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Description of EPA SITE Demonstration of the HAZCON Stabilization Process at the Douglassville, Pennsylvania Superfund Site

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One technology field tested under the SITE research program was the HAZCON stabilization process. This process treats the waste by mixing it with portland cement, water (if needed) and chloranan, a proprietary chemical. By comparing the chemical and physical properties of the waste before and after treatment, this field demonstration developed data on the strength and leaching potential expected after treatment from a range of waste characteristics. Six wastes at the Douglassville, PA Superfund Site, containing up to 25 percent organics and 2 percent lead, were treated and evaluated. The Physical strength (200 to 1500 psi) and durability, i.e., long-term stability, of the stabilized wastes were good. Even in wastes with high levels of organics (25 percent), stabilization of lead was very successful. Leachin results determined that lead concentrations dropped by factors between 100 and 1000 after treatment. Stabilization of organics, however, achieved mixed results. Leachate concentrations generally did not change between treated and untreated samples. It could not be determined if this was a failure of the treatment process or an anomaly of the test procedure.

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DESCRIPTION OF EPA SITE DEMONSTRATION OF THE HAZCON STABILIZATION PROCESS AT THE DOUGLASSVILLE, PENNSYLVANIA SUPERFUND SITE

by

Paul R. de Percin
Superfund Technology Demonstration Division
Risk Reduction Engineering Laboratory
U.S. Environmental Protection Agency
Cincinnati, Ohio 45268

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SITE PROGRAM UPDATE: PART III

Description of EPA SITE Demonstration of the HAZCON Stabilization Process at the Douglassville, Pennsylvania Superfund Site

Paul R. de Percin
Superfund Technology Demonstration Division
U.S. Environmental Protection Agency
Cincinnati, Ohio

One technology field tested under the SITE research program was the HAZCON stabilization/solidification process. This process treats the waste by mixing it with portland cement, water (if needed) and Chloranan, a proprietary chemical. By comparing the chemical and physical properties of the waste before and after treatment, this field demonstration developed data on the strength and leaching potential expected from a range of waste characteristics after stabilization. Six wastes at the Douglassville, Pennsylvania Superfund site, containing up to 25 percent organics and 2 percent lead, were treated and evaluated. The physical strength (200 to 1500 psi) and durability, i.e., long-term stability, of the stabilized samples were good. Even in wastes with high levels of organics (25 percent), stabilization of lead was very successful. Leaching results determined that lead concentrations dropped by factors between 100 and 1000 after treatment. Stabilization of organics, however, achieved mixed results. Leachate concentrations generally did not change between treated and untreated samples. It could not be determined if this was a failure of the treatment process or an anomaly of the test procedure.

In response to the Superfund Amendments and Reauthorization Act of 1986 (SARA), the U.S. Environmental Protection Agency's Offices of Research and Development (ORD) and Solid Waste and Emergency Response (OSWER) have established a formal program to accelerate the development, demonstration, and use of new or innovative technologies as alternatives to current containment systems for hazardous wastes. This new program is called Superfund Innovative Technology Evaluation or SITE.

The major objectives of the SITE Program are to develop reliable performance and cost information. One technology, which was demonstrated at the Douglassville, Pennsylvania Superfund site, is the HAZCON proprietary solidification process. This process involves the mixing of hazardous waste material and cement with a patented nontoxic chemical called Chloranan. Chloranan is claimed to neutralize the inhibiting effects that organic contaminants normally have on the hydration of cement based materials. For this treatment technology, the wastes are immobilized and bound by encapsulation into a hardened leach-resistant concrete-like mass.

The Douglassville, Superfund site was selected as the location for the demonstration test because of its high organic and lead concentrations. This is a 20 hectare (50 acre) rural site of an oil recovery facility that includes: two large lagoons once filled with oily sludge, an oily filter cake disposal area, an oil drum storage area, an area where generated sludge was landfarmed into the soil and the plant processing area. More than 200,000 cubic meters of soil is contaminated.

Field Demonstration Objectives

The major objectives of the HAZCON field demonstration were to determine:

- The ability of the HAZCON stabilization/solidification technology to immobilize the site contaminants. These include heavy metals, oil and grease, volatile and semivolatile organics, and polychlorinated biphenyls (PCBs).
- The effectiveness of the technology for treating soils with oil and grease concentrations between 1 and 25 percent.
- The performance and reliability of the process system.
- The probable long-term stability and integrity of the stabilized soil or waste.
- The costs for commercial-scale applications.

In developing the sampling and analysis plan, two major criteria were identified for judging the success of the HAZCON stabilization process; integrity of the treated waste and the mobility of the toxic contaminants. Integrity of the treated waste was evaluated by measuring the physical properties and observing the microstructure of the hydrated matrix. Mobility was determined by the leachability of the contaminants and the permeability of the treated waste.

Site Description

The Douglassville Superfund site is located in a rural setting surrounded by croplands and light residential and industrial development, and covers 20 hectares (Figure 1). About 3 hectares (7 acres) of the site were formerly used as two lagoons, lagoon north (LAN) and lagoon south (LAS), to settle wastewater sludge generated by the facility's oil recy-

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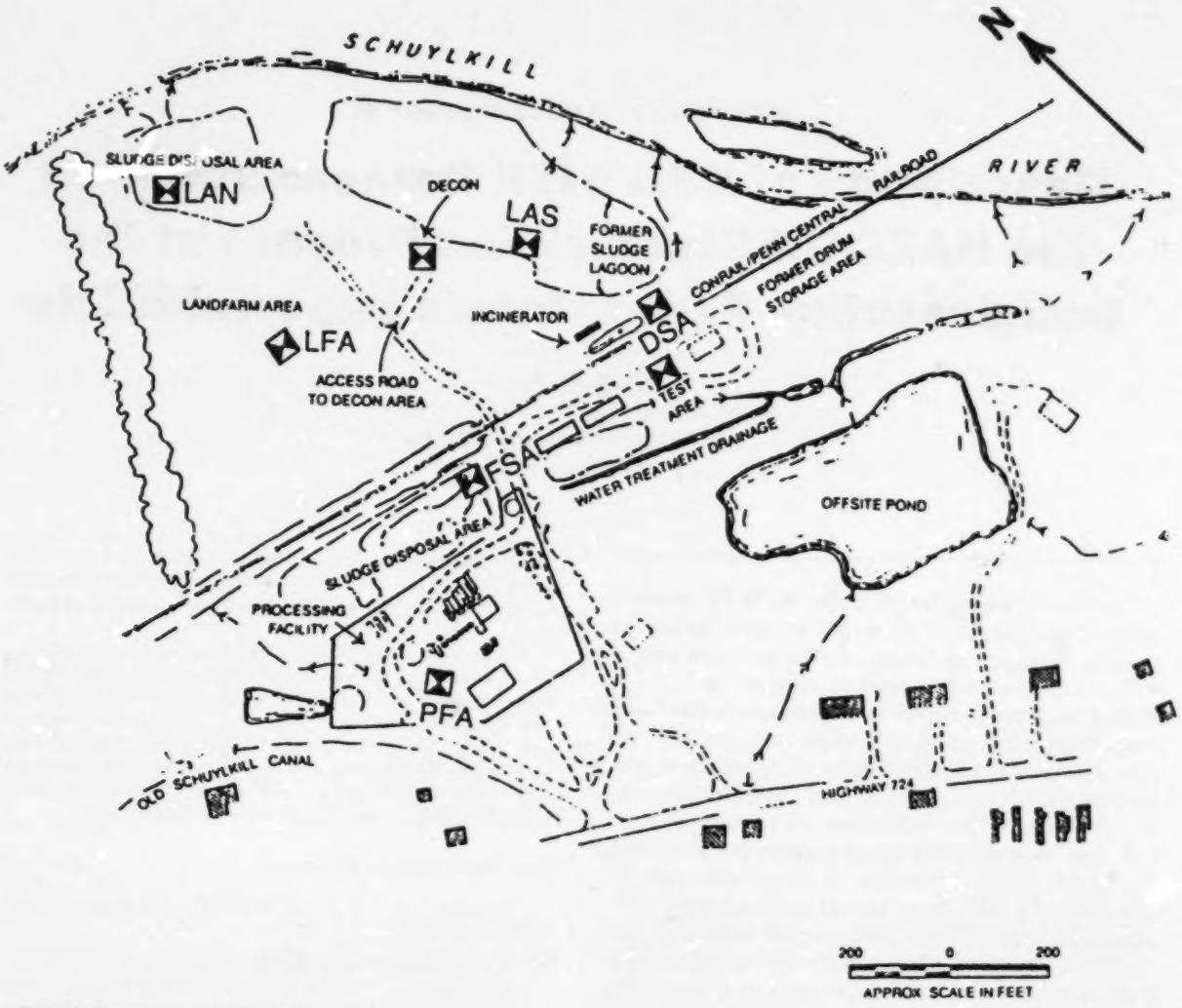

Figure 1. Demonstration test sampling layout.

cling process. After the flood in 1972, both lagoons were drained and backfilled. One of the former lagoons, located in the northwestern corner, is in an area where oil sludge was landfarmed (LFA) from 1979 through 1981. This area was unsuccessfully used for agricultural purposes between 1981 and 1984. The second lagoon was located in the northeastern corner of the site.

Located in the southern portion of the site are the recycling facility and office buildings. This is referred to as the plant facility area (PFA). Just east of the PFA is a three-quarter hectare (1 acre) area filled about 2 to 2.5 meters (6 to 8 feet) deep with oily filter sludge, called the filter sludge storage area (FSA). To the south, near the drainage ditch, is an area that was used for the storage of hundreds of drums of oil and oily water (drum storage area—DSA).

These six waste areas were contaminated primarily with lead and oil and grease, and with minor concentrations of volatile and semivolatile organics and PCBs (Table I). Waste concentrations were in the following ranges:

- Lead: 0.3–2.2 percent
- Oil and grease: 1.0–25.3 percent
- Volatile organics: 0–150 ppm
- Semivolatile organics: 12.2–534 ppm
- PCBs: 1.2–54 ppm
- pH: 2.6–7

The high levels of lead, oil, and grease in the waste were the deciding factor for selecting the Douglassville Superfund site for this demonstration. It is known that organics and lead can interfere with the stabilization process and it was felt that these wastes would be difficult to satisfactorily treat.

Process Description

HAZCON Engineering, Inc.'s mobile field blending unit (MFU) operates a continuous processing unit. Operating speeds, though governed by predetermined mix ratios set in the laboratory, are variable up to 15 cubic yards of processed raw waste per operating hour. The MFU has no external utility requirements other than a standard water hook-up and the attachment of a "quick connect" line from a bulk cement carrier. The mobile field blending unit, consisting of bin, tank, auger sizes, and component locations, is shown in Figure 2.

Equipment calibration was performed each time a new waste feed matrix entered the MFU. Calibration involves the determination of the waste feed by weight, then the subsequent setting of the admixture flowrates to the appropriate ratios.

Table I. Chemical analyses of untreated soil.

Parameter	DSA	LAN	FSA	LFA	PFA	LAS
PCBs (ppm)	1.2	51	40	10	34	52
Lead (ppm)	3230	9250	22600	13670	7930	14830
Oil and Grease %	0.98	16.5	25.3	4.27	4.47	7.80
BNAs—total (ppm)	12.2	20.9	434	36.7	18.4	39.6
Volatiles—total (ppm)	ND	2.44	150	ND	0.42	0.29

Waste material is introduced to the system through the use of pumps, dredges, or earth moving equipment, whichever may be the most efficient or practical. The waste is moved through the process in a controlled flow, allowing for precise measurement of the material. Based upon these measurements, blending ratios, which are predetermined in the laboratory, are set on a time weighted basis for both the Chloranan and pozzonalic material, such as portland cement.

The mobile blending unit contains some limited storage of the additives. The pozzolanic ingredient is stored in a hopper and then metered into the mix. Typical ratios, on a weight basis, range from 1 part waste: 1 part pozzolan, to 3 parts waste: 1 part pozzolan.

Chloranan is stored in a holding tank, then pumped into the mixing chamber. Through precise control of the flowrate, ratios of waste to Chloranan can be accurately metered from a 10:1 to a 50:1 blend.

All additives are fed via pump or auger through a mixing chamber to achieve a homogenous blend. The resultant mass was extruded into either temporary or permanent molds.

Demonstration Program

Six different contaminated soils at the Douglassville site were processed by HAZCON from the following locations: lagoon north (LAN), lagoon south (LAS), filter cake storage area (FSA), drum storage area (DSA), plant facility area (PFA), and landfarm area (LFA). The intent was to process 5 cubic yards from 5 areas. An extended duration run for the sixth area was to determine the reliability of the operating equipment. Approximately 25 cubic yards of the stabilized LAS contaminated soil were produced. The actual runs used less feedstock, which produced approximately 5 and 25 cubic yards of treated soil.

The contaminated soil was excavated and screened to remove material greater than 3 inches. It was then fed to the HAZCON mobile field blending unit (MFU—the truck mounted system) along with portland cement, water and Chloranan. Cement was used on an approximately 1:1 basis with soil, and the soil to Chloranan ratio was 10:1. Table II presents the operating data for the six wastes. The four feed components were blended in a mixing screw and fed to five 1-cubic yard wooden molds for the short tests and three 1-cubic-yard plus two 12-cubic yard pits for the LAS. During the processing of three soils (DSA, LFA and PFA), toluene was injected into the soil to attain a concentration of 100 ppm. It was felt that this would allow before and after concentrations within the detection limits.

While the contaminated soil was processed and cured, the excavation holes were enlarged, lined with an impervious plastic liner, and partially filled with clean soil. After the 1-cubic yard blocks cured sufficiently to be moved (48–96 hours), they were removed from the molds and placed into the pits. The blocks were then covered with additional clean soil. After 28 and 210 days, the blocks were sampled. It is proposed that after burial the blocks be sampled again every year, for perhaps as long as five years.

Sampling and Analysis Program

Soil samples were taken before treatment, as a slurry exiting the MFU for analysis after seven days and as cores from the buried blocks after 28 and 210 days of curing. For the 5-cubic yard blocks, two untreated soil composite samples were taken along with three sets of slurry and solidified cores. For the extended run at LAS, additional samples were taken for analysis.

The specific analyses performed on soil, slurry and core samples included measuring physical properties, such as:

- Bulk density
- Moisture content
- Permeability
- Unconfined compressive strength of the solidified cores
- Weathering tests

Chemical analyses were performed to identify the organic and metal contaminants in the soil processed. In addition, three different leaching tests were run:

- *Toxicity characteristic leaching procedure (TCLP).* Standard leaching procedure used for measuring leach-

Table II. Summary of HAZCON MFU operating conditions.

	DAS	LAN	FSA	LFA	PFA	LAS
Soil feed, lb/min	300	210	234	224	216	178
Cement, lb/min	306	212	240	228	220	183
Chloranan, lb/min	28.3	16.7	12.2	20.0	17.1	21.1
Water, lb/min	114	88	133	79	81	98
Total feed addition, lb/min	748.3	526.7	619.2	551.0	534.1	480.1
Total soil, lb	4765	4478	4308	6570	4891	19385
Total cement, lb	4860	4521	4418	6688	4982	19928
Total Chloranan, lb	450	360	225	585	387	2295
Total water, lb	1810	1890	2450	2316	1832	10659
Total weight, lb	11885	11249	11401	16159	12092	52267(d)
Bulk density, lb/cu ft (slurry core)	122	100	94	115	129	106
Total volume, cu yd	3.6	4.2	4.5	5.2	3.5	18.3
Cement/soil ratio	1.02	1.01	1.03	1.02	1.02	1.03
Chloranan/soil ratio	0.094	0.080	0.052	0.089	0.079	0.119
Water/soil ratio	0.38	0.42	0.57	0.35	0.38	0.55
Soil total feed ratio	0.40	0.40	0.38	0.41	0.40	0.37
Number of 1-cu-yd blocks	4	5	5	5	<4	—
Operating time, minutes (based upon chronology)	15.9	21.5	18.4	29.3	22.6	170

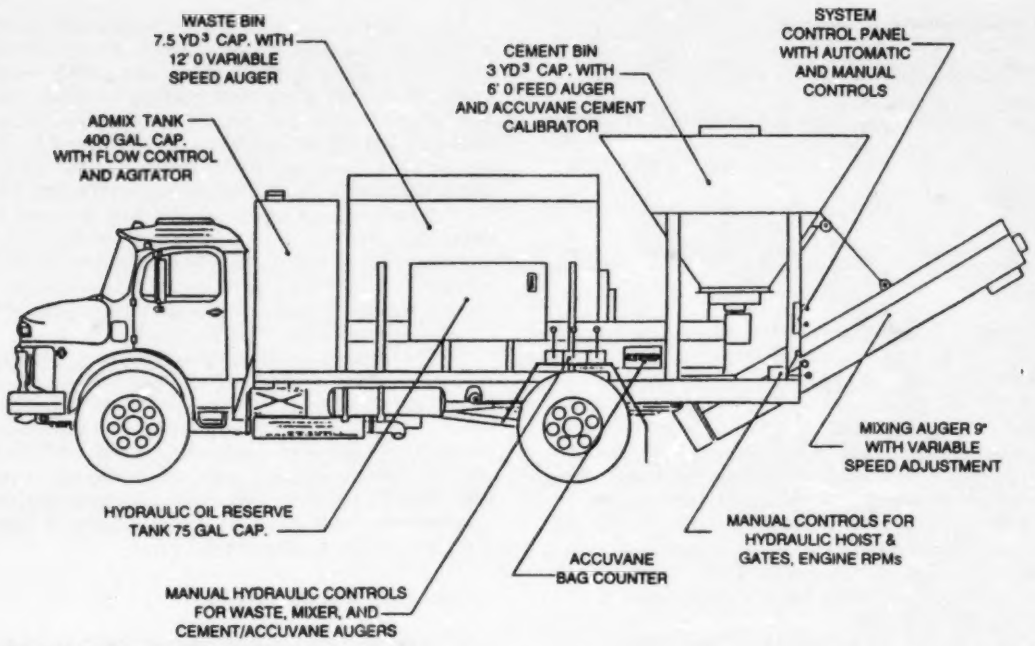

Figure 2. Equipment layout diagram.

ability of the contaminants (USEPA regulatory procedure).

- *ANS 16.1.* Simulates leaching from the intact solidified core with rapidly flowing groundwater (ANS—American Nuclear Society).
- *MCC-1P.* Simulates leaching from the intact solidified core in relatively stagnant groundwater regimes (MCC—Materials Characterization Center, Richland, Wash.).

Table III. Physical properties of treated soils—28-day samples.

Plant area	Moisture %	Bulk density g/ml	Unconfined compressive strength, psi	Permeability cm/sec
DSA	14.8	1.99	1113	1.8×10^{-9}
LAN	17.2	1.59	524	4.0×10^{-9}
FSA	22.1	1.51	219	8.4×10^{-8}
LFA	15.1	1.86	945	4.5×10^{-9}
PFA	10.0	2.02	1574	5.0×10^{-9}
LAS	15.8	1.74	889	2.2×10^{-9}

These latter two tests were drawn from the nuclear industry and modified to soil hazardous waste analyses.

Finally, microstructural studies were performed on the untreated soil and solidified cores. These analyses included:

- *X-ray diffractometry.* Identifies crystalline structures in the solid.
- *Microscopy.* Scanning electron microscope and optical microscope—identifies level of porosity, crystal appearance, agglomerates, and fractures.

Demonstration Results

The comparison of the soil, 7-day, 28-day and 210-day sample test results were generally favorable. The physical test results were very good, with unconfined compressive strength between 220 to 1570 psi (Table III). Very low permeabilities were developed and the porosity of the treated wastes were moderate. Durability test results were very good—there were generally no changes in physical strength after the wet/dry and freeze/thaw cycles for both the 28-day and 210-day samples. The microstructural analyses seemed to indicate possible sample degradation in the future. The future sample core testing will confirm or deny these projections. There was a waste volume increase of about 120 percent. By using less stabilizer, smaller volume increases can be obtained, but lower strengths will result. There is an inverse relationship between physical strength and the waste organic concentration.

The results of the leaching tests were mixed (Table IV). The TCLP results of the stabilized wastes were very low; essentially all values of metals, volatile organics and semivolatile organics were below 1 ppm. Lead leachate concentrations dropped by a factor of 200 from the untreated soil results, to below 100 ppb. Volatile and semivolatile organic concentrations, however, did not change from the untreated soil TCLP. Oil and grease concentrations were greater in the treated waste TCLPs than the untreated waste, from less than 2 ppm to 2–4 ppm. PCBs could not be detected (<1 ppb) in the TCLP leachates for either the treated or untreated wastes.

Results from the specific tests are as follows:

- The volume of the solidified soil was approximately double that of the undisturbed feedstock. It is expected that this volume increase can be avoided by using higher

Table IV. TCLP leachate concentrations—28-day sample results.

Plant area	Lead (ppb)	BNAs total (ppb)	Volatiles total (ppb)	PCBs (ppb)
DSA	7	ND	396	ND
LAN	5	1450	55	ND
FSA	400	2790	740	ND
LFA	50	100	393	ND
PFA	11	110	858	ND
LAS	51	730	112	ND

waste to stabilizer ratios. While this probably will decrease the strength of the sample somewhat, the stength should still be satisfactory.

- Permeabilities of the treated soil were very low, in the range of 10^{-8} to 10^{-9} cm/sec. A value of 10^{-7} is generally considered satisfactory for landfill soil liners.
- The unconfined compressive strengths (UCS) of the solidified soils ranged from about 100 psi for FSA to 1500 psi for PFA and the values were inversely proportional to the oil and grease concentration. These values are quite satisfactory from a structural stability viewpoint.
- Unconfined compressive strength tests were performed after the wet/dry and freeze/thaw cyclical weathering tests for both the 28-day and 210-day samples. For these tests, the UCS changed very little (1–2 percent) from that of the uncycled cores. It was noticed that the field cured samples had strengths less than the laboratory cured samples by as much as 30 percent. It is suspected that the cause is the ideal curing conditions used to store the laboratory samples.

The TCLP leaching test results are as follows:

- *Metals.* The leachates for the solidified soils showed metal levels at or near the detection limits. The results were 500 to 1000 less than in the leachates for the untreated soils.
- *Volatiles.* The primary compounds detected were trichloroethene, tetrachloroethene, toluene and xylenes. Only the leachates for the untreated soil and 7-day cores were analyzed. The levels of contaminants were approximately the same in both the treated and untreated soils at levels of hundreds of micrograms per liter.
- *BNAs.* The compounds detected in the leachates were phthalates and phenols. The phthalates were reduced to near their detection limits of 10 μg/l in both the treated and untreated soil leachates. The total phenols in the leachates were in the range of hundreds of micrograms per liter, with the same concentration levels seen in both the untreated and untreated soil leachates.
- *PCBs.* PCBs were not detected in the TCLP leachates for either the untreated or treated samples. It is thought the acetic acid leachant is not effective in removing PCBs from solids.

Leachate results for the ANS 16.1 and MCC-1 were obtained and compared to the TCLP results. It is not known if it is appropriate to compare these leaching results and exactly what the comparisons mean.

The ANS 16.1 procedure had a metals leachate concentration similar to the TCLP, but a volatile organics concentration half of the TCLP and a semivolatile organic concentration slightly less than the TCLP.

The MCC-1 leaching procedure had results different from the ANS procedure, as expected. The metals leachate concentration was 5 to 10 times the TCLP concentration. Volatile organic leachate concentration were similar to the TCLP while semivolatile organics were half that of TCLP.

The microstructural studies provided the following information. It should be emphasized that this is an experimental procedure, based on the experience of the tester.

It is the opinion of the scientists who performed the microscopic evaluations that the long-term durability of the stabilized waste was questionable. The treated soils were very porous and the mixing of the four process components appeared poor. Globules of organic and untreated cement could be seen. It is not known which of the microscopic or wet/dry and freeze/thaw tests are valid procedures for estimating long-term durability.

Economic Analysis

Estimates for the cost for utilizing the HAZCON solidification process were prepared. It was assumed that approximately 15 percent of the Douglassville site was treated as part of a total site remediation. Eight cases were investigated utilizing the following sets of variables:

- *On-stream factor.* 70 percent the best seen during the demonstration and 90 percent the value projected by HAZCON for full-scale field commercial operation.
- *Production rates.* 300 lb/min was the maximum thoughput during the demonstration and 2300 lb/min was estimated for a field commercial unit.
- *Chemical Additive Rates.* The projected full-scale field rates of portland cement and Chloranan addition are 33 percent less than used during the demonstration.

The costs per ton of processed soil ranged from $90 to $200. The lowest cost occurred for a 90 percent on-stream factor, the high production rate unit, and reduced chemical consumption. The two cost factors with the largest influence were production rate and chemical additive rate. Approximately 90 percent of the total cost for processing the soil were labor and chemical costs.

References

1. "Technology Evaluation Report," SITE Program Demonstration Test, HAZCON Solidification, Douglassville, Pennsylvania, U.S. Environmental Protection Agency, RREL-0002, August 1988.

Paul R. de Percin is a Chemical Engineer with the Office of Research and Development, U.S. Environmental Protection Agency, 26 West Martin Luther King Drive, Cincinnati, OH 45268. This paper was submitted for peer review on December 13, 1988. The revised manuscript war .eceived February 2, 1989.

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